CLAIM OR CLAIMS

WHAT IS CLAIMED IS:

1. An apparatus for use with an adaptive orthogonal frequency division-multiplexing (OFDM) system that uses multiple input multiple output (MIMO) structure to transmit OFDM signals from a plurality of transmitters to a plurality of receivers, the OFDM signal having an OFDM frame of a duration, the OFDM frame having data packets and a plurality of OFDM slots, each of the OFDM slots having a plurality of OFDM symbols that include a plurality of sub-carriers, the apparatus comprising:

a receiver that responds to receipt of the OFDM signal by making a determination as to whether time diversity or spatial diversity should be used for subsequent transmissions and transmits a feedback signal indicative of that determination, an implementation of the time diversity resulting in a better robustness to counter signal fading than if the spatial diversity were implemented and an implementation of spatial diversity resulting in an increase in a rate of data packet transfer over that if the time diversity were implemented, because the OFDM signals that are transmitted over multiple ones of the transmitters are independent of each other for the spatial diversity and correspond to each other for the time diversity.

2. An apparatus as in claim 1, wherein the receiver includes a controller that makes the determination based on a comparison of a channel condition with a threshold, the channel condition being based on a frequency response channel matrix that is derived from OFDM symbols.

3. An apparatus as in claim 2, wherein the channel condition is based on a calculation of a smallest eigen value of the frequency response channel matrix.

4. An apparatus as in claim 2, wherein the channel condition is based on a determination of a smallest element in a diagonal of the frequency response channel matrix.

5. An apparatus as in claim 2, wherein the channel condition represents a ratio of largest and smallest eigen values of the channel matrix.

6. An apparatus as in claim 2, wherein the channel condition is based on one of three criteria selected from a group consisting of a calculation of smallest eigen values of the channel matrix, a smallest element in a diagonal of the channel matrix, and a ratio of largest and smallest eigen values of the channel matrix.

7. An apparatus as in claim 2, further comprising a channel estimator that forms the frequency response channel matrix.

8. An apparatus as in claim 2, wherein the controller is configured to classify the sub-carriers into one of two groups in accordance with the channel condition, one of the two groups being indicative of time diversity and the other of the two groups being indicative of spatial diversity, the controller being further configured to determine a modulation scheme on each of the classified sub-carriers based on an estimated ratio selected from a further group consisting of a carrier to interference ratio and a signal to noise ratio.

9. An apparatus for use with an adaptive orthogonal frequency division-

multiplexing (OFDM) system that uses multiple input multiple output (MIMO) structure to transmit OFDM signals from a plurality of transmitters to a plurality of receivers, the OFDM signal having an OFDM frame of a duration, the OFDM frame having data packets and a plurality of OFDM slots, each of the OFDM slots having a plurality of OFDM symbols that include a plurality of sub-carriers, the apparatus comprising

at least one controller configured and arranged to respond to a feedback signal to direct an encoder to assign constellation points to the sub-carriers in accordance with a channel condition so as to classify each of the sub-carriers into one of two groups, the encoder including a space time transmitter diversity (STTD) encoder and a spatial multiplexing (SM) encoder, the STTD encoder being arranged to encode the sub-carriers classified in one of the groups in accordance with time diversity and the SM encoder being arranged to encode the sub-carriers classified in the other of the groups in accordance with spatial diversity, an implementation of the time diversity resulting in a better robustness to counter signal fading than if the spatial diversity were implemented and an implementation of spatial diversity resulting in an increase in a rate of data packet transfer over that if the time diversity were implemented, because the OFDM signals that are transmitted over multiple ones of the transmitters are independent of each other for the spatial diversity and correspond to each other for the time diversity.

10. An apparatus as in claim 9, wherein the controller is configured to determine a modulation scheme on each of the sub-carriers based on an estimated ratio selected from a further group consisting of a carrier to interference ratio and a signal to noise ratio.

11. An apparatus for use with an adaptive orthogonal frequency division

multiplexing (OFDM) system that uses multiple input multiple output (MIMO) structure to transmit OFDM signals from a plurality of transmitters to a plurality of receivers, the OFDM signal having an OFDM frame of a duration, the OFDM frame having data packets and a plurality of OFDM slots, each of the OFDM slots having a plurality of OFDM symbols that include a plurality of sub-carriers, the apparatus comprising:

controllers configured and arranged to direct transmission and reception in accordance with OFDM, the controllers including those associated with the reception that are configured to responds receipt of the OFDM signal by making a determination as to whether time diversity or spatial diversity should be used for subsequent transmissions and transmits a feedback signal indicative of that determination, an implementation of the time diversity resulting in a better robustness to counter signal fading than if the spatial diversity were implemented and an implementation of spatial diversity resulting in an increase in a rate of data packet transfer over that if the time diversity were implemented, because the OFDM signals that are transmitted over multiple ones of the transmitters are independent of each other for the spatial diversity and correspond to each other for the time diversity, the controllers associated with the reception being configured to direct that transmission of at least one feedback signal occur that reflects the determination, the controllers including those associated with the transmission that are responsive to receipt of the feedback signal to direct an encoder to assign constellation points to the sub-carriers in accordance with a channel condition so as to classify each of the sub-carriers into one of two groups, the encoder including a space time transmitter diversity (STTD) encoder and a spatial multiplexing (SM) encoder, the STTD encoder being arranged to encode

the sub-carriers classified in one of the groups in accordance with the time diversity and the SM encoder being arranged to encode the sub-carriers classified in the other of the groups in accordance with the spatial diversity.

12. An apparatus as in claim 11, wherein the controller is configured to determine a modulation scheme on each of the sub-carriers based on an estimated ratio selected from a further group consisting of a carrier to interference ratio and a signal to noise ratio.

13. An apparatus as in claim 12, wherein the controllers associated with the reception are configured to make a calculation of eigen values of channel matrices to make a determination as to which sub-carriers are to use the time diversity to reduce signal fading forward error correction (FEC) during a subsequent transmission and which sub-carriers are to use the spatial diversity to increase a rate of data transfer during the subsequent transmission, the controllers associated with the reception being configured to make the determination based on a comparison between a threshold and at least one of three criteria and to direct transmission of a feed back signal indicative of a result of the determination, at least one of the criteria being based on the calculation, at least another of the criteria being based on elements of a diagonal of at least one of the channel matrices.

14. An apparatus as in claim 12, wherein the controllers associated with the reception are configured so to make the determination based on a comparison of a channel condition with a threshold, the channel condition being based on a frequency response channel matrix that is derived from OFDM symbols.

15. An apparatus as in claim 14, wherein the channel condition represents a calculation of a smallest eigen value of the frequency response channel matrix.

16. An apparatus as in claim 14, wherein the channel condition represents a determination of a smallest element in a diagonal of the frequency response channel matrix.

17. An apparatus as in claim 14, wherein the channel condition represents a ratio of largest and smallest eigen values of the channel matrix.

18. An apparatus as in claim 14, wherein the channel condition represents one of three criteria selected from a group consisting of a calculation of smallest eigen values of the channel matrix, a smallest element in a diagonal of the channel matrix, and a ratio of largest and smallest eigen values of the channel matrix.

19. An apparatus as in claim 14, further comprising a channel estimator that forms the frequency response channel matrix.

20. A method for use with an adaptive orthogonal frequency division -multiplexing (OFDM) system that uses multiple input multiple output (MIMO) structure to transmit OFDM signals from a plurality of transmitters to a plurality of receivers, the OFDM signal having an OFDM frame of a duration, the OFDM frame having data packets and a plurality of OFDM slots, each of the OFDM slots having a plurality of OFDM symbols that include a plurality of sub-carriers, the method comprising:

responding to receipt of the OFDM signal by making a determination as to whether time diversity or spatial diversity should be used for subsequent transmissions and transmits a feedback signal indicative of that determination, an implementation of the time

diversity resulting in a better robustness to counter signal fading than if the spatial diversity were implemented and an implementation of spatial diversity resulting in an increase in a rate of data packet transfer over that if the time diversity were implemented, because the OFDM signals that are transmitted over multiple ones of the transmitters are independent of each other for the spatial diversity and correspond to each other for the time diversity.

21. A method as in claim 20, further comprising making the determination based on a comparison of a channel condition with a threshold, the channel condition being based on a frequency response channel matrix that is derived from OFDM symbols.

22. A method as in claim 21, further comprising calculating a smallest eigen value of the frequency response channel matrix basing the channel condition on the calculating.

23. An method as in claim 21, further comprising determining a smallest element in a diagonal of the frequency response channel matrix and basing the channel condition on the determining.

24. A method as in claim 21, further comprising calculating a ratio of largest and smallest eigen values of the channel matrix and basing the channel condition on the ratio.

25. A method as in claim 21, further comprising basing the channel condition on one of three criteria selected from a group consisting of a calculation of smallest eigen values of the channel matrix, a smallest element in a diagonal of the channel matrix, and a ratio of largest and smallest eigen values of the channel matrix.

26. A method as in claim 20, further comprising classifying the sub-carriers into two groups one of the two groups being indicative of time diversity and the other of the two

groups being indicative of spatial diversity, determining a modulation scheme on each of the classified sub-carriers based on an estimated ratio selected from a further group consisting of carrier to interference ratio and signal to noise ratio.

27. A method for use with an adaptive orthogonal frequency division-multiplexing (OFDM) system that uses multiple input multiple output (MIMO) structure to transmit OFDM signals from a plurality of transmitters to a plurality of receivers, the OFDM signal having an OFDM frame of a duration, the OFDM frame having data packets and a plurality of OFDM slots, each of the OFDM slots having a plurality of OFDM symbols that include a plurality of sub-carriers, the method comprising

responding to a feedback signal to direct an encoder to assign constellation points to the sub-carriers in accordance with a channel condition so as to classify each of the sub-carriers into one of two groups, the encoder including a space time transmitter diversity (STTD) encoder and a spatial multiplexing (SM) encoder, the STTD encoder being arranged to encode the sub-carriers classified in one of the groups in accordance with time diversity and the SM encoder being arranged to encode the sub-carriers classified in the other of the groups in accordance with spatial diversity, an implementation of the time diversity resulting in a better robustness to counter signal fading than if the spatial diversity were implemented and an implementation of spatial diversity resulting in an increase in a rate of data packet transfer over that if the time diversity were implemented, because the OFDM signals that are transmitted over multiple ones of the transmitters are independent of each other for the spatial diversity and correspond to each other for the time diversity.

28. A method as in claim 27, further comprising classifying the sub-carriers into two groups, one of the two groups being indicative of time diversity and the other of the two groups being indicative of spatial diversity, determining a modulation scheme on each of the classified sub-carriers based on an estimated ratio selected from a further group consisting of a carrier to interference ratio and a signal to noise ratio.

29. A method for use with an adaptive orthogonal frequency division-multiplexing (OFDM) system that uses multiple input multiple output (MIMO) structure to transmit OFDM signals from a plurality of transmitters to a plurality of receivers, the OFDM signal having an OFDM frame of a duration, the OFDM frame having data packets and a plurality of OFDM slots, each of the OFDM slots having a plurality of OFDM symbols that include a plurality of sub-carriers, the method comprising:

directing transmission and reception in accordance with OFDM by using controllers, the controllers including those associated with the reception responding to receipt of the OFDM signal by making a determination as to whether time diversity or spatial diversity should be used for subsequent transmissions and transmits a feedback signal indicative of that determination, an implementation of the time diversity resulting in a better robustness to counter signal fading than if the spatial diversity were implemented and an implementation of spatial diversity resulting in an increase in a rate of data packet transfer over that if the time diversity were implemented, because the OFDM signals that are transmitted over multiple ones of the transmitters are independent of each other for the spatial diversity and correspond to each other for the time diversity, the controllers associated with the reception directing that transmission of

at least one feedback signal occur that reflects the determination, the controllers including those associated with the transmission that respond to receipt of the feedback signal to direct an encoder to assign constellation points to the sub-carriers in accordance with a channel condition so as to classify each of the sub-carriers into one of two groups, the encoder including a space time transmitter diversity (STTD) encoder and a spatial multiplexing (SM) encoder, the STTD encoder being arranged to encode the sub-carriers classified in one of the groups in accordance with the time diversity and the SM encoder being arranged to encode the sub-carriers classified in the other of the groups in accordance with the spatial diversity.

30. A method as in claim 29, wherein the controllers associated with the reception make a calculation of eigen values of channel matrices to make a determination as to which sub-carriers are to use the time diversity to reduce signal fading forward error correction (FEC) during a subsequent transmission and which sub-carriers are to use the spatial diversity to increase a rate of data transfer during the subsequent transmission, the controllers associated with the reception make the determination based on a comparison between a threshold and at least one of three criteria and to direct transmission of a feed back signal indicative of a result of the determination, at least one of the criteria being based on the calculation, at least another of the criteria being based on elements of a diagonal of at least one of the channel matrices.

31. A method as in claim 29, wherein the controllers associated with the reception make the determination based on a comparison of a channel condition with a threshold, the channel condition being based on a frequency response channel matrix that is derived from OFDM symbols.

32. A method as in claim 31, further comprising calculating a smallest eigen value of the frequency response channel matrix basing the channel condition on the calculating.

33. A method as in claim 31, further comprising determining a smallest element in a diagonal of the frequency response channel matrix and basing the channel condition on the determining.

34. A method as in claim 31, further comprising calculating a ratio of largest and smallest eigen values of the channel matrix and basing the channel condition on the ratio.

35. A method as in claim 31, further comprising basing the channel condition on one of three criteria selected from a group consisting of a calculation of smallest eigen values of the channel matrix, a smallest element in a diagonal of the channel matrix, and a ratio of largest and smallest eigen values of the channel matrix.

36. A method as in claim 29, further comprising determining a modulation scheme on each of the sub-carriers based on an estimated ratio selected from a further group consisting of a carrier to interference ratio and a signal to noise ratio.